Effectiveness of the Soil Conditioning Index to Predict Soil Organic Carbon Sequestration in the Southeastern USA

Alan J. Franzluebbers
USDA-Agricultural Research Service, Watkinsville Georgia USA
alan.franzluebbers@ars.usda.gov

Hector J. Causarano
National University of Asuncion, PARAGUAY
hector.causarano@tigo.com.py

M. Lee Norfleet
USDA-Natural Resources Conservation Service, Temple Texas USA
lnorfleet@brc.tamus.edu

Background

Soil organic C (SOC) is a key component in developing sustainable agricultural production systems, as well as for reducing CO_2 flux to the atmosphere.

Conservation agricultural systems are needed to preserve the capacity of agricultural production, to protect the environment from pollution, and to sequester soil organic C.

Soil conditioning index (SCI) is a relatively simple model used by USDA-Natural Resources Conservation Service (NRCS) to pay landowners enrolled in the Conservation Security Program (for environmental protection of America's farmland).

The SCI is run as part of the Revised Universal Soil Loss Equation (RUSLE2).

The SCI is a function of three components known to affect soil organic C:

1. Organic material (OM) grown or added to soil,
2. Field operations (FO) that alter organic material placement in the soil profile and that stimulate organic matter breakdown,
3. Erosion (ER) that removes and sorts surface soil organic matter.

Validation of SCI against actual soil organic C changes in the field has been minimal, but is needed considering that payments are made of \$28.65 ha^{-1} yr^{-1} times positive SCI values.

Hot, wet climate of the southeastern USA creates unique conditions for soil organic C sequestration.

Objective

To validate SCI against published soil organic C from field studies throughout the southeastern USA.

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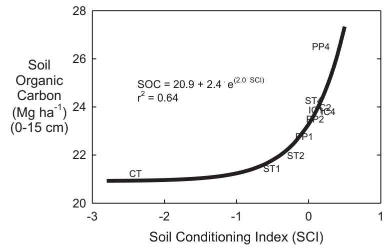
"GRACEnet (Greenhouse Gas Reduction through Agricultural Carbon Enhancement network): An Assessment of Soil Carbon Sequestration and Greenhouse Gas Mitigation by Agricultural Management"

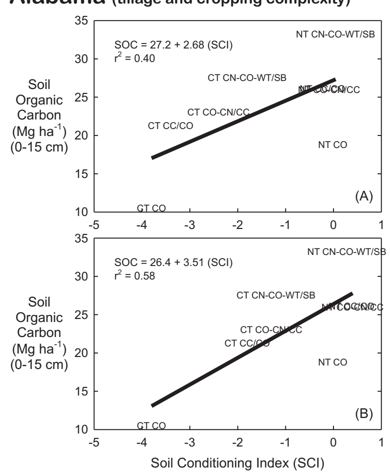
Results

Georgia (tillage type / frequency)



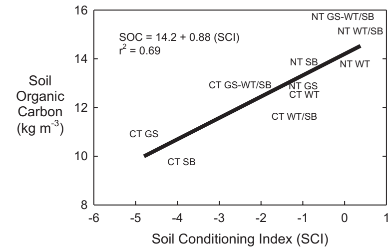
On a Cecil sandy loam in Watkinsville GA, soil organic C at the end of 4 yr of management was non-linearly related to SCI. Management was pearl millet / clover rotated with cotton / clover under different types (conventional disk tillage and no- tillage planting with either paraplow, in-row chisel, or shallow cultivation) and frequencies (1, 2, and 4 years out) of tillage. Data from Franzluebbers et al. (1999, SSSAJ 63:349-355).

Alabama (tillage and cropping complexity)



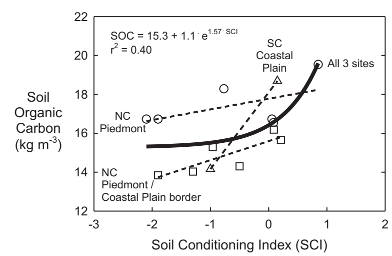
On a Pacolet sandy loam in Auburn AL, soil organic C at the end of 3.5 yr of no-tillage management following 100 yr of conventional-tillage management was linearly related to SCI (Panel A). Cropping systems were (1) cotton, (2) clover / cotton, (3) clover / cotton - clover / corn, and (4) clover / cotton - clover / corn - wheat / soybean. SCI allowed only 900 kg/ha dry matter accumulation for clover. Changing cover crop to wheat (4600 kg/ha dry matter) resulted in a better SOC-SCI relationship (Panel B). Data from Siri-Prieto et al. (2002; South. Conserv. Tillage Proc.).

Texas (tillage and crop selection/rotation)



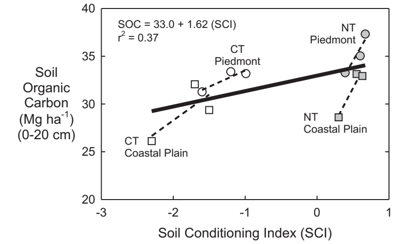
On a Weswood silty clay loam in College Station TX, soil organic C was linearly related to SCI. Management was (1) soybean, (2) grain sorghum, (3) wheat, (4) wheat / soybean, and (5) sorghum - wheat / soybean under conventional disk tillage and no tillage for 9, 10, and 20 yr. Soil sampling was to 15, 20, or 30 cm; soil organic C was normalized to account for differences. Data from Franzluebbers et al. (1994, SSSAJ 58:1639-1645; 1995, SSSAJ 59:460-466; 1998, STR 47:303-308); Wright and Hons (2004, SSSAJ 68:507-513; 2005, SSSAJ 69: 141-147); Dou and Hons (2006, SSSAJ 70:1896-1905).

North and South Carolina (MLRA location)



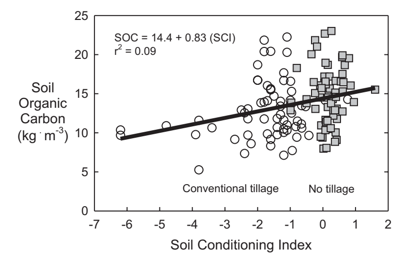
Comparing across locations within North and South Carolina (Piedmont, Coastal Plain, and their borders), strength of the relationship between soil organic C and SCI was still reasonable (r^2 = 0.40). Management systems were (1) barley silage / corn silage, (2) rye / corn silage, and (3) rye / corn silage - rye / sudangrass in the NC Piedmont, (4) corn - soybean, (5) corn - wheat / soybean, and (6) corn - peanut - cotton in the NC border, and (7) wheat / cotton - corn - wheat / soybean in the SC Coastal Plain. Soil sampling was to 7.6, 12.5, 15, and 20 cm; soil organic C was normalized to account for differences. Time was 6-25 yr. Data in SC from Karlen et al. (1989, CSSPA 20:1413-1426); Hunt et al. (1996, JSWC 51:255-258); Novak et al. (1996, AEE 60:165-173; 2007, SSSAJ 71:453-456); Ding et al. (2002, Chemo 48: 897-904); Bauer et al. (2006, STR 90:205-211). Data in NC from Naderman et al. (2004, pers comm); Franzluebbers and Brock (2007, STR 93:126-137).

Maryland (tillage, location, and N fertilization)



On Piedmont and Coastal Plain sites in Maryland, soil organic C and SCI were highly linearly related in continuous corn systems fertilized to achieve low, medium, and high grain yield. These data illustrated (1) strong effect of organic matter input from fertilizer on soil organic C and SCI and (2) strong effect of no tillage on SCI, but less so on actual soil organic C. Data from McCarty and Meisinger (1997, BFS 24:406-412).

All southeastern USA sites



From 260 observations throughout the region, SCI was only weakly related to soil organic C. Both SCI and soil organic C were greater ($p<0.001$) under no tillage than under conventional tillage.

Conclusions

Soil conditioning index (SCI) was highly sensitive to tillage.
Within a location, SCI was highly related to soil organic C (SOC).
Modifications to SCI management inputs may be necessary.
Variations in SOC protocol require some standardization.
Further work is needed to better define the relationship between SCI and SOC at high SCI values.

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